RAND Research Brief

F-15 Avionics Intermediate Maintenance Options for Expeditionary Air Force Support

In the current Air Force support system for F-15 avionics, each base with F-15 aircraft has an avionics intermediate-maintenance shop (AIS) for repairing avionics line-replaceable units (LRUs), or components that are removed and replaced by flight line mechanics. Under present policy, the AIS is deployed with aircraft from home bases to forward operating locations (FOLs) in what we refer to as a decentralized-deployment support option. This system places a heavy deployment burden on avionics personnel and requires substantial airlift for the AIS equipment. Also adversely affected are the Expeditionary Aerospace Force (EAF) goals of increasing response speed, reducing strain on personnel, and diminishing the deployment footprint, or the amount of materiel that must deploy with a force.

What F-15 avionics maintenance options might the Air Force consider in its efforts to achieve EAF goals? We examine alternatives that eliminate or reduce AIS deployments by providing spare-parts replenishments to FOLs through distribution rather than local repair, comparing these alternatives both to each other and to the current system. These include:

- The current decentralized-deployment system
- A decentralized-no-deployment system in which each AIS supports deployed aircraft from home instead of deploying with aircraft to FOLs
- A single continental United States (CONUS) support location (CSL) with consolidated repair for worldwide support in both peace and war
- A CSL in network with two, three, or four regional repair forward support locations (FSLs) that would support operations in both peace and war.

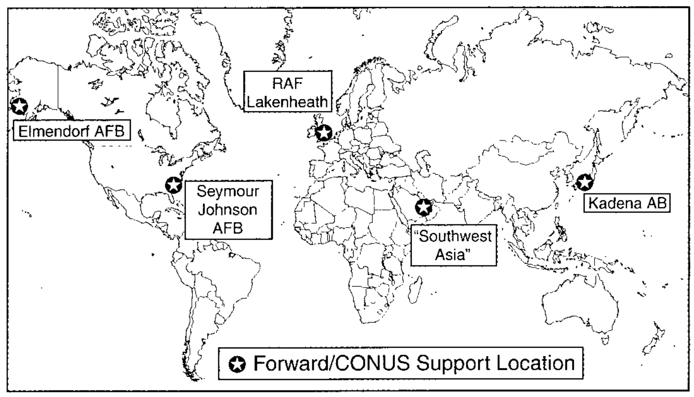

Figure 1—Notional Four FSL and One CSL Structure

Figure 1 presents a notional support structure comprising four FSLs and one CSL located at existing and hypothetical bases.

Our analysis focuses on the system costs, deployment requirements, and operational risks associated with each of these alternatives. We also consider how technological change and the transformation of current processes would affect system performance in meeting EAF goals. We consider, for example, how faster order-and-ship times (OSTs) and implementation of the Electronic System Test Set (ESTS) being developed to reduce deployment footprint and personnel requirements would affect comparisons between support structure alternatives.

SYSTEM COSTS

To compare the costs of the various alternatives, we calculated the present value of operating and investment costs and found that the consolidated alternatives reduce annual operating costs in exchange for initial investments

in F-15 avionics serviceable spare parts. The level of consolidation affects the balance of this tradeoff in that greater consolidation yields the most significant reduction in personnel costs, but this gain is offset by even greater increases in spare-parts requirements as well as by lesser increases in transportation costs. The net result is that, using the current testers and assuming current OSTs, the four-FSL / one-CSL option yields the lowest net cost of the consolidated alternatives and is the only alternative that is cost-competitive with the current decentralized-deployment system. Reducing OSTs would make the four-FSL / one-CSL system less costly than the current system.

Each alternative using the ESTS and current OSTs would be more costly than the current system using the ESTS. This is because adoption of ESTS in itself produces some of the personnel savings generated by consolidation, the biggest cost advantage of consolidated systems. With the ESTS, reducing OSTs makes the four-FSL / one-CSL option only slightly more expensive than the current system.

REDUCING EQUIPMENT AND PERSONNEL DEPLOYMENT REQUIREMENTS

Quick-hitting expeditionary operations require rapid deployment of combat forces, placing a premium on reducing deployment footprint, or the amount of initial airlift needed to transport support equipment. For a major theater war deployment, all the alternatives we considered would reduce deployment footprint for F-15 avionics maintenance capabilities by up to 60 C-141 or 43 C-17 load equivalents. The ESTS also greatly reduces deployment footprint for the current system, so the alternatives we considered would generate a further reduction in deployment footprint of only 12 C-141 or 9 C-17 load equivalents beyond that gained through ESTS.

The current decentralized structure has high and frequent personnel deployment requirements. The consolidated structures would eliminate deployment requirements for some small-scale contingencies and would reduce them for major theater wars. Each consolidated alternative we consider would also be less stressing than those required by the current system in that deployments would be to FSLs rather than to FOLs, which are more likely to be in hostile areas. Of course, the decentralized-no-deployment structure would eliminate deployment personnel requirements.

Personnel retention problems have made it difficult for the Air Force to maintain the required skill-level mix of personnel in areas such as F-15 avionics repair. To solve this problem, the Air Force can either work toward improving the retention of its current personnel or find other sources of repair personnel. The Air Force has attributed its personnel retention problems to frequent deployments to FOLs over the last decade. RAND research on the effects of deployment on personnel retention conceptually supports this contention but also concludes that a low to moderate level of deployment, particularly to nonhostile locations such as those in which FSLs would be positioned, has a positive effect on personnel retention.[1] By this standard, a CSL in network with FSLs would be the most favorable alternative for personnel retention, but the elimination of deployments would probably remain preferable to excessive deployments to FOLs in potentially hostile environments. Alternatively, the elimination of deployments to FOLs gives the Air Force flexibility in how it decides to achieve required personnel levels. Should the Air Force seek to find other sources of repair personnel, eliminating deployments or keeping them limited to FSLs would allow for the use of contractors, government-employed civilians, or allied partnerships.

RISK

Decentralized and consolidated structures carry different operational risks. Decentralized deployment is associated with risks in equipment deployment, setup, and downtime. Current planning assumes that the AIS will deploy and be operational by day three of flying operations. Any difficulties encountered in deploying or setting up this complex equipment and in making it fully operational will delay resupply as well. Moreover, if just a single set of testers is deployed to a location—as should be the case when only one squadron deploys to an FOL—then the squadron using those testers faces a "single-string" risk wherein a breakdown of just one tester can halt resupply for an entire group of parts. Resupply shortfalls can result in the decline of aircraft availability below planned levels. "Emergency" setup of an unplanned distribution channel to the FOL could mitigate resupply shortfalls resulting from tester-associated risks.

For both the consolidated and the decentralized-no-deployment alternatives that we consider, the need to set up an effective wartime distribution system between repair and operating locations is the major source of risk. Delays in implementation would hinder resupply in much the same manner as would delays in deploying testers under a decentralized-deployment policy. Similarly, any gap between the OST planning assumptions used to plan forward inventory levels and that actually achieved would result in a resupply capability that would be unable to support the planned level of aircraft availability. This risk may increase as customs regulations or the remoteness of operating locations increases.

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[1]See James Hosek and Mark Totten, *Does Perstempo Hurt Reenlistment: The Effect of Long or Hostile Perstempo on Reenlistment*, RAND, MR-990-OSD, 1998.

SUMMARY OF ALTERNATIVE COMPARISONS

The current decentralized-deployment policy, which calls for slightly higher levels of personnel and testers than those in place today, could provide the same level of support at the same cost as, or at a lower cost than, the alternatives we examine. Disadvantages such as personnel instability, deployment footprint, and equipment setup and "single-string" risks, however, have already led many deploying units to modify their procedures on an ad hoc basis.

Modifying the current system to eliminate AIS deployment, as in the decentralized-no-deployment option, eliminates personnel and equipment deployment requirements but requires a one-time increase in spare parts for the supply pipeline. Furthermore, a moderate level of personnel deployment rather than the elimination thereof may be of most benefit to retention.

The four-FSL / one-CSL option is cost-competitive with the current decentralized-deployment option and addresses each of its disadvantages. It offers a moderate level of personnel deployment to nonhostile locations and eliminates equipment deployment and its accompanying risks. These benefits may be offset somewhat by the risk inherent in quickly establishing effective wartime intratheater distribution.

A TEST OF A REGIONAL F-15 REPAIR FSL

During Operation Noble Anvil (ONA), the air war against Serbia, the 48th Component Repair Squadron at RAF Lakenheath implemented the FSL repair concept as part of a system of FSLs set up by United States Air Forces in Europe, thereby formalizing practices they had used on an ad hoc basis for several years. They were able to successfully support their own aircraft at FOLs as well as concurrent deployments to Southwest Asia using existing assets without any deployment of AIS personnel or equipment. In fact, between October 1998 and March 1999, as tensions rose or eased, the wing supported by this squadron made seven different partial-unit deployments back and forth from Lakenheath to Southwest Asia and Italy without moving the AIS (Figure 2). Normally, Air Force policy would require that these deployments include the AIS, but since all of the units were supported from the Lakenheath FSL, no support equipment had to move. As a result, airlift requirements for these seven deployments were reduced by 35 C-141 sorties. More than any theoretical description of the flexibility that FSLs can provide in today's dynamically shifting environment, these operations demonstrated the advantage nondeploying maintenance structures confer in facilitating the repositioning of forces as quickly as political situations change.

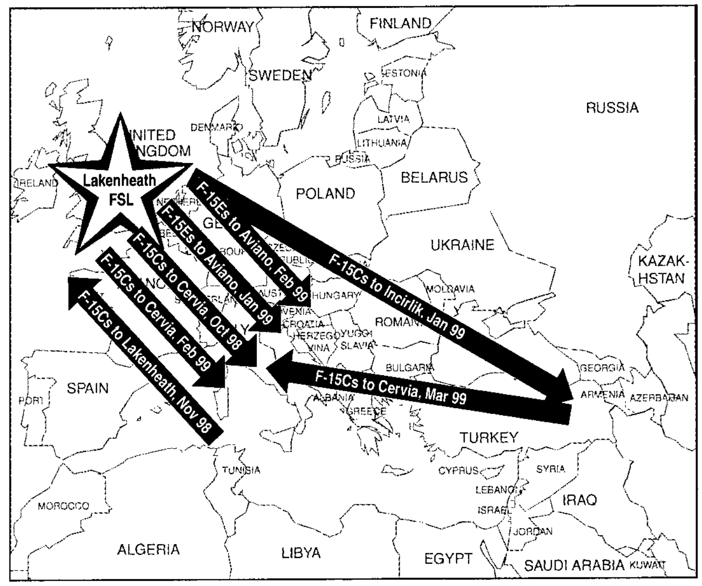

Figure 2—The Lakenheath FSL facilitated operational flexibility during a time of heavy political turbulence. Lakenheath's F-15 deployments over a five-month span—which would have required seven moves of avionics intermediate-maintenance equipment and personnel under the current official decentralized-deployment policy—were completed without any deployment of avionics intermediate-maintenance capability.

The squadron also implemented plans for the Lakenheath avionics maintenance FSL to support an augmentation of F-15s from CONUS for ONA with just half the deployment footprint and personnel that would have been required had the deploying-wing AIS moved to the new FOL. In a permanent consolidated structure, even this limited equipment deployment would not have been required because the equipment would already have been in place; thus, only personnel would have had to deploy. In exchange for the reduction in deployment airlift, the FSL had to rely on a steady flow of transportation to provide resupply to the operating locations.

Lakenheath logisticians used their prior experience, including that gained in the October 1998 deployment to Cervia, Italy (Figure 2), to conduct transportation planning for providing support from an FSL. This enabled it to provide rapid and responsive resupply of serviceable parts to FOLs from the start of ONA through the intratheater distribution system and a Lakenheath-managed "distribution system" that augmented the joint system. The Lakenheath distribution system was critical to the success of the operation. Other Air Force FSLs established in support of ONA relied solely on the joint intratheater distribution system but did not find that system sufficiently responsive.

CONCLUSION

The key issue in determining whether to adopt an alternative F-15 avionics support structure seems to lie in the level of risk posed by the need to quickly establish a

wartime theater distribution system. We recommend that the Air Force review current plans for wartime theater distribution and then work as part of the joint community to modify them as necessary to address potential performance gaps. Even if the Air Force then elects to continue with the current structure, improving the wartime theater distribution system would reduce equipment risk. Assuming that the Air Force and joint community develop "reliable" plans for wartime theater distribution, we recommend the adoption of a consolidated network of regional repair locations to reduce deployment burdens and enhance flexibility should the Air Force continue to use the current testers. Such a network would provide more benefits than ESTS adoption at less cost. If the Air Force proceeds with ESTS implementation, however, the alternative systems would cost more than the current policy and would provide fewer benefits. In this case, the reduced personnel deployment requirements and flexibility provided by the alternative structures should be weighed against their associated spare-parts investment requirements.

RAND research briefs summarize research that has been more fully documented elsewhere. This research brief describes work done for RAND's Project AIR FORCE; it is documented in Eric Peltz, Hyman Shulman, Robert Tripp, Timothy Ramey, and John Drew, Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options, *MR-1174-AF, 2000, 144 pp., ISBN 0-8330-2881-0, available from RAND Distribution Services (Telephone: 310-451-7002 or call toll free 877-584-8642; FAX: 310-451-6915; E-mail: order@rand.org). Abstracts of RAND documents may be viewed on the World Wide Web (http://www.rand.org). RAND® is a registered trademark. RAND is a nonprofit institution that helps to improve policy and decisionmaking through research and analysis. Its publications do not necessarily reflect the opinions or policies of its research sponsors.*

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